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SHORT COMMUNICATION

NEMATODE AND DIPTERAN ENDOPARASITES OF THE WOLF SPIDER *PARDOSA MILVINA* (ARANEAE, LYCOSIDAE)

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ABSTRACT. We collected 75 immature *Pardosa milvina* and maintained them in a laboratory until death or maturity to determine whether *P. milvina* in our population were harboring endoparasites. Nine mermithid nematodes emerged from *P. milvina* hosts, with each nematode emerging from a separate spider. One dipteran parasite, an acrocerid, emerged from *P. milvina*. This study provides the first published record of nematodes emerging from *P. milvina* and documents an additional record of acrocerid parasitism of *P. milvina*.

Keywords: Spiders, endoparasites, nematodes, acrocerids

The first report of nematode parasitism in spiders was in 1761 by Roesel (Poinar 1987). All reports of naturally occurring nematode/spider associations are for nematodes in the family Mermithidae (Poinar 1987). Rhabditoid nematodes, which naturally parasitize soil insects, have also been documented in spiders, but only in laboratory situations. However, since rhabditoid nematodes cause mortality within two to three days of entry, they may often be missed in the field (Poinar 1987). Mermithids cause behavioral and morphological changes in spiders, including slower reaction times to predators (Leech 1966), movement toward water (Poinar 1985, 1987), abdominal swelling, deformed epigyna, malformed legs and pedipalps, poor development of secondary sexual characteristics, and castration (Leech 1966; Poinar & Benton 1986).

Dipteran endoparasites of spiders are found in the families Tachinidae (Vincent 1985) and Acroceridae (Schlinger 1993). Acrocerids, small headed flies, are the only truly co-evolved and host-restricted endoparasitoids of spiders (Schlinger 1993). There are approximately 500 species in 50 genera of acrocerids, and the majority of larvae are endoparasites of spiders.

Pardosa milvina (Hentz 1844) is a lycosid spider with the largest females measuring approximately 6.2 mm in length, and the largest males measuring approximately 4.7 mm (Kaston 1981). These lycosids are found in dry, open woods and along the shores of ponds and streams from New England south to Georgia and west to the Rockies (Kaston 1981). To date, there are no records of endoparasitic nematodes from *P. milvina*, and the only acrocerid recorded from *P. milvina* is *Ogcodes eugonatus* (Eason et al. 1967; Schlinger 1993). Our study documents the first published record of nematodes emerging from *P. milvina*. We also report on an acrocerid emerging from *P. milvina*.

In 1998, we collected *P. milvina* at the Rock Springs Center for Environmental Discovery, Decatur, Illinois. We were collecting spiders for a behavioral study, and parasite emergence was an unexpected occurrence. We collected 75 immature spiders from the south shore of a pond from 1 June–9 July. None of the spiders had any noticeable external morphological abnormalities. Spiders were held individually in plastic petri dishes (14.5 cm diameter x 1.7 cm height) in a laboratory in Decatur, IL. We fed all spiders three times per week. Immature spiders received 12 fruit flies, *D. melanogaster*, at each feeding. As spiders reached the penultimate and adult stages, they received 2 houseflies, *M. domestica*, at each feeding. All spiders had constant access to water via saturated cotton balls.

We maintained all spiders in the laboratory until they either died or successfully molted to adulthood. As spiders died, we checked their arenas for the presence of nematode or dipteran parasites. Only two non-parasitized spiders died. Upon emergence, we immediately collected nematode parasites because juvenile mortality is high under laboratory conditions due to bacterial or fungal infections (Poinar 1987). Nematode parasites could only be identified to family because adult males are needed for identification to genus. Nematodes were identified by Dr. Robert P. Esser (Florida Dept. of Agriculture & Consumer Services, Gainesville,

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FL). Although we maintained an acrocerid parasite until maturity, it could not be identified to genus because of wing damage. The dipteran was identified by Dr. Peter H. Adler (Clemson University, Clemson, SC). Voucher specimens of host spiders, mermithids, and the single acrocerid have been deposited in The Field Museum of Natural History, Chicago, IL.

Nine mermithid nematodes emerged from *P. milvina* hosts, with each nematode emerging from a separate spider. All nematodes emerged from the spiders' ventral abdomen and were subsequently located in the spiders' saturated cotton balls. Nematodes emerged from 1–8 days after spider collection. Prior to emergence, there were no noticeable changes in host behavior or morphology. On 8 August, a dipteran parasite, an acrocerid, emerged from the abdomen of a penultimate female *P. milvina* that was collected on 16 June. Two days prior to acrocerid emergence, we noticed a change in the appearance of the hosts' book lung, and it is likely we were viewing the spiracles of the acrocerid. All ten spider hosts died within 24 hours of parasite emergence. All parasites emerged from immature spiders, although three spiders were penultimate females and one was a penultimate male.

Mermithid parasitism of lycosid hosts is an understudied area. Early researchers believed spiders were parasitized by mermithids when there were no suitable insect hosts available (Poinar 1987). It is currently believed that nematodes parasitizing spiders represent different species than those parasitizing insects (Poinar 1987); however, literature on nematode parasitism of spiders is scarce. Mermithids kill their spider hosts upon emergence, and their life cycle is largely unknown. Difficulty of nematode identification hinders progress. Adult males are required for species level identification, but adults are rarely collected because nematodes emerge from hosts as juveniles and are difficult to rear. After exiting the host, juvenile mermithids mature in soil or mud. Adults are non-feeding and live for a few days to months, depending on their stored food supply (Barnes 1980).

Although mermithids parasitize a diversity of spider families and approximately 20 lycosid species (Poinar 1987), this is the first record of a mermithid endoparasite in *P. milvina*. Minimal work has been conducted on the incidence of mermithid parasitism in a particular spider population. *Pardosa milvina* in our semi-aquatic pond habitat experienced 8% infection. Populations of *Pardosa glacialis* (Thorell 1872) in Canada experienced from 0–5% infection, with a greater incidence of infection in poulations near streams (Poinar 1987). A California population of *Atypoides riversi* O. P.-Cambridge 1883 exhibited 8% infection (Poinar 1987).

There are many spider taxa parasitized by acrocerids (Eason et al. 1967; Cady et al. 1993; Schlinger 1993), and strict host specificity is rare (Cady et al. 1993; Schlinger 1993). Acrocerids seek out cursorial or fossorial spider hosts or web builders that construct webs either close to the ground or with silk connections to vegetation (Cady et al. 1993). Female acrocerids oviposit in the environment and, upon hatching, larvae locate spider hosts, crawl to the abdomen or leg joints, and cut a small hole in the exoskeleton to enter the host. Larvae then migrate into the booklungs where they are exposed to oxygen (Schlinger 1993). Fourth instar larvae are the destructive stage because they actively feed on spider tissues from the legs, cephalothorax, and abdomen. *Lasiodora klugi* (C. L. Koch 1841), *Coras montanus* (Emerton 1890), and *Pardosa lapidicina* Emerton 1885 constructed atypical thick silk mats prior to acrocerid emergence, and acrocerid larvae subsequently used the mats for pupation (Cady 1984 in Cady et al. 1993; Eason et al. 1967). Larvae typically emerge from the spider's epigastric furrow, locate host silk, and use ventral abdominal spines to attach to the silk where they undergo pupation. Hosts usually die twelve hours prior to parasitoid emergence (Schlinger 1993).

Much remains to be discovered about the associations between endoparasites and their spider hosts. Parasitic occurrences should be reported because additional records may increase our understanding of the distribution, life cycle, and natural history of endoparasites and their possible impact on spider populations. We hope our results will stimulate others to report their finding and add to our our basic understanding of spider/parasitoid biology.

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